WHAT IS CLAIMED IS:

1. A method for measuring the integrated area Q_{gT} of a pulse-like input signal applied to a device characterized by one or more decay time constants in said device's impulse response function by measuring a step-like output signal, referred to as the primary signal, provided by said device in response to said pulse-like input signal, the method comprising:

creating a set of secondary signals by directing the primary signal into a plurality of signal paths;

performing a filtering or delaying operation in at least one of said signal paths;

applying a set of weighting coefficients to said secondary signals within said signal paths;

summing said secondary signals to provide a time correlated, weighted filter sum signal; and

performing at least one capturing operation after any filtering or delaying operations to produce a value of said time correlated, weighted filter sum signal, following said capturing and summing operations, that is a measure of said integrated area Q_{gT} of said input signal;

wherein said filtering, delaying and/or capturing operations establish a defined time correlation between said secondary signals with respect to one another prior to said secondary signals being summed; and

wherein said weighting coefficients applied to the secondary signals are selected, based on the nature of any filters used in said filtering operations, on the defined time correlation established between said secondary signals, and on the values of the one or more decay time constants associated with said device, to compensate said measured area Q_{gT} for the risetime structure of said step-like pulse, for the presence of more than one decay time constant, or for both.

2. The method of claim 1 wherein said secondary signals are all summed at a single summation point.

3. The method of claim 1 wherein said secondary signals are summed at a plurality of summation points.

4. The method of claim 1 wherein, for at least one secondary signal the application of the weighting coefficient occurs prior to the performance of a filtering or delaying operation.

5. The method of claim 1 wherein, for at least one secondary signal, the performance of the filtering operation occurs prior to the performance of a delaying operation or the application of a weighting coefficient.

6. The method of claim 1 wherein, for at least one secondary signal, the performance of the delaying operation occurs prior to the performance of a filtering operation or the application of a weighting coefficient.

7. The method of claim 1 wherein, for at least one secondary signal, a first filter with a shorter time domain plus a delay are replaced by a second filter whose time domain is approximately equal to the length of the time domain of the first filter plus the length of the replaced delay and said weighting coefficients are adjusted accordingly.

8. The method of claim 1 wherein, for at least one secondary signal, said filtering operation also includes a decimation operation.

9. The method of claim 1 wherein said capturing operation after said summing operation.

10. The method of claim 9 wherein said capturing operation occurs is in response to the detection of maximum in summed signal.

11. The method of claim 1 wherein:

said capturing operation includes capturing one or more of said secondary signals following any filtering or delaying operations in their associated signal paths; and

said secondary signals that are summed are captured values of said one or more secondary signals propagating along said associated signal paths.

12. The method of claim 11 wherein said weighting coefficients are applied to said captured values of said one or more secondary signals prior to summing said captured values.

13. The method of claim 11 wherein said weighting coefficients are applied to said one or more secondary signals prior to said to capturing operation.

14. The method of claim 13 wherein, for at least one of said one or more secondary signals propagating in their associated signal paths, the application of the weighting coefficient occurs prior to the performance of a filtering or delaying operation.

15. The method of claim 11 wherein said capturing one or more secondary signals includes capturing the entire set of secondary signals.

16. The method of claim 11 wherein said delaying operation is carried out for at least a first secondary signal by delaying the first secondary signal's time of capture relative to the time of capture of a second secondary signal.

17. The method of claim 11 wherein said delaying operation is carried out for at least a first captured secondary signal by introducing a propagation delay into first secondary signal's associated signal path that is different from the propagation delay in the associated signal path of a second captured secondary signal.

18. The method of claim 17 wherein said introduced propagation delay is adjusted so that said capturing of said first and second captured secondary signals are carried out simultaneously

19. The method of claim 1 wherein said capturing operation is carried out in response to detecting a step-like feature in said primary signal.

20. The method of claim 19 wherein said capturing operation includes measuring one or more predetermined times after said detecting a step-like feature and capturing one or more secondary signals or said summed signal at the end of said one or more predetermined times..

21. The method of claim 19 wherein said capturing operation includes measuring a first predetermined time after said detecting a step-like feature and then detecting and capturing the peak value of said summed signal that occurs within a second predetermined time interval.

22. The method of claim 19, and further comprising recording the time at which said step-like feature is detected.

23. The method of claim 19 wherein said detected step-like feature is inspected for pileup and said capturing operation is carried out only if said detected step-like feature is not piled-up.

24. The method of claim 1 wherein said summed signal is compared to a threshold value and said capturing operation is only initiated if the summed signal exceeds the threshold value.

25. The method of claim 1 wherein multiple secondary signal paths share the same filtering operation.

26. The method of claim 1 wherein at least one secondary signal path does not contain a filtering operation, so that the secondary signal being summed after traveling along this signal path is a weighted copy of said primary signal.

27. The method of claim 1 wherein, in at least one secondary signal path, an analog-to-digital conversion (ADC) operation is carried out following one or more of said filtering, delaying, or weighting operations, and the remaining filtering, delaying, or weighting operations are carried out digitally.

28. The method of claim 27 wherein multiple secondary signal paths share the same ADC operation by applying said ADC operation to the primary signal and then directing the resultant digitized primary signal into said multiple secondary signal paths.

29. The method of claim 27 wherein, in those secondary paths where filtering operations are carried out digitally, at least one trapezoidal or triangular digital filter is employed.

30. The method of claim 29 wherein, when a trapezoidal digital filter is employed, the sensitivity of its contribution to said captured, weighted signal sum value on the risetime structure of said step-like pulse is reduced by making the trapezoidal digital filter gap length longer than the longest expected step-like pulse risetime.

31. The method of claim 27 wherein, in those secondary paths where filtering operations are carried out by digital means, at least one running average filter is employed.

32. The method of claim 1 wherein said pulse-like input signal has a finite time extent, a time-varying amplitude, or both.

33. The method of claim 1 wherein said filtering, delaying, weighting, and summing operations are all performed continuously, so that said sum of time correlated, weighted, filtered signals is also a continuous signal.

34. The method of claim 1 wherein one or more of said filtering, delaying, or weighting operations is carried out using analog circuitry.

35. The method of claim 1 wherein said weighting coefficients are calculated for a selected set of filtering and delaying operations by:

developing a mathematical model of said device's response to said pulse-like input signal in terms of:

i) a set of one or more first type (type P_1) parameters that characterize said device's amplitude response to said pulse-like input signal;

ii) a set of one or more second type (type P_2) parameters that characterize said device's residual amplitude response to any previous pulse-like input signals; and

iii) a set of one or more third type (type P_3) parameters that characterize the transfer functions of said device and of said filtering and delaying operations;

convolving said modeled response by said delaying and filtering operations to produce a set of linear equations between the unweighted contributions from said secondary signal paths to said captured weighted signal sum value and said sets of type P_1 and type P_2 parameters;

solving said set of linear equations for the values of said P_1 and P_2 parameters in terms of said unweighted contributions; and

expressing the desired integrated area Q_{gT} in terms of said type P_1 and type P_2 parameters to obtain an integrated area equation relating Q_{gT} to the values of said unweighted contributions, where the coefficients of said unweighted contributions in said integrated area equation are the desired weighting coefficients.

36. The method of claim 1 wherein said device has a DC offset or a minor higher-order pole term in its output, and further comprising:

directing baseline secondary signals to a baseline summation point along baseline secondary signal paths providing filtering, delaying, or weighting operations;

making baseline measurements by capturing weighted baseline sum values from said baseline summation point at times when said baseline secondary signals reaching said baseline summation point are not responding to step-like features in said primary signal; and

using one or more of said baseline measurements to correct said measurement of said integrated area Q_{gT} for the presence of said DC offset or said minor higher order pole term, or both.

37. The method of claim 36 wherein said baseline secondary signals and said secondary signals are summed at the same point, and the same secondary signal

paths contribute to both the weighted signal sum values and weighted baseline sum values.

38. The method of claim 36 wherein said baseline secondary signals and said secondary signals are summed at different points, and different secondary signal paths contribute to said weighted signal sum values than contribute to said weighted baseline sum values.

39. The method of claim 38 wherein some secondary signal paths are directed to both of the different points

40. The method of claim 36 wherein the number of poles is 2, with said minor higher order pole being the second order pole.

41. The method of claim 36 wherein said baseline measurements are scaled according to the time decay behavior of said minor higher order pole before being used to make said correction of said measurement of integrated area Q_{gT}.

42. The method of claim 43 wherein said scaling is accomplished by multiplying said measurements by factors of the form $\exp(-\Delta t/\tau_m)$, where τ_m is the decay constant of the minor pole and Δt is the time between successive baseline measurements or the time between the last baseline measurement and said time of capturing said weighted signal sum value as a measure of said integrated area Q_{gT}.

44. The method of claim 36 wherein multiple baseline measurements are made and averaged prior to being used to make said correction.

45. The method of claim 44 wherein said baseline measurements are only used to correct for a DC offset and said multiple baseline measurements are averaged using a running sum average.

46. The method of claim 44 wherein said baseline measurements are only used to correct for a DC offset and said multiple baseline measurements are averaged using an exponentially decaying average of the form $\langle b\rangle_i = (N-1)^* \langle b\rangle_{I-1}/N + b_i/N$, where

b_i is the i^{th} baseline measurement, $\langle b\rangle_i$ is the i^{th} baseline average, and N is a constant.

47. The method of claim 44 wherein said multiple baseline measurements, after correction for the DC offset, are averaged using an exponentially decaying average of the form $<b>_i = (N-1)* \exp(-\Delta t_i/\tau_m) <b>_{I-i}/N + b_i/N$, where

b_i is the i^{th} baseline measurement, $<b>_i$ is the i^{th} baseline average, N is a constant, and Δt_i is the time between the i^{th} baseline measurement and its predecessor.

48. The method of claim 47 wherein estimated values of the DC offset used in making said correction for DC offset are obtained from time to time by:

first, measuring a pair of said baseline values without an intervening step-like pulse, and,

second, computing a weighted difference of said pair of values.

49. The method of claim 36 wherein values of Q_{gT} for previously detected step-like pulses are also used to correct said integrated area Q_{gT} for the presence of said minor higher order pole term.

50. The method of claim 1 wherein said multi-pole device is a preamplifier having one or more decay constants and said integrated area Q_{gT} of a pulse-like signal input to the preamplifier represents the charge produced in a detector attached to the preamplifier due to an absorption event in said detector

51. The method of claim 50 wherein said preamplifier has only two poles, namely a major first pole and a minor second pole, so that said preamplifier is a nominally single-pole (N-1P) device.

52. The method of claim 51 wherein said weighting coefficients are selected to compensate said measurement of charge Q_{gT} for at least the presence of said minor second pole.

53. The method of claim 51 wherein said weighting coefficients are selected ignoring the presence of said minor second pole, and

baseline measurements are used to correct the measurement of charge Q_{gT} for the presence of said minor second pole or said DC offset, or both.

54. The method of claim 1 wherein said device is a superconducting bolometer having one or more decay constants and said integrated area Q_{gT} of a pulse-like signal input to the preamplifier represents the heat released in a detector attached to the preamplifier due to an absorption event in said detector.

55. The method of claim 1 wherein said device is a scintillator material having one or more decay constants, said step-like pulse output is the light emitted by the scintillator material in response to an absorption event, and said integrated area Q_{gT} of a pulse-like input signal represents the energy deposited in the scintillator material by said absorption event..

56. The method of claim 55 wherein said energy Q_{gT} is assumed to be proportional to the total light output by said scintillator material in response to said absorption event, said total light output being proportional to the total area under said step-like pulse output signal.

57. The method of claim 55 wherein said weighting coefficients are calculated for a selected set of filtering and delaying operations by:

developing a mathematical model of said scintillator material's response to said deposited energy in terms of:

i) a first type (type σ_g) parameter equal to the area under said step-like pulse in a risetime region;

ii) a set of one or more second type (type Q_{gi3}) parameters that characterize the increase in the amplitudes of one or more exponential decay terms immediately following said risetime region;

iii) a set of one or more third type (type Q_{i3}) parameters that characterize the residual amplitudes of said one or more exponential decay terms due to any previous energy depositions; and

iv) a set of one or more fourth type (type P_4) parameters that characterize said scintillator's one or more exponential decay times τ_i and said filtering and delaying operations;

convolving said modeled response by said delaying and filtering operations to produce a set of linear equations between the unweighted contributions (σ_i) from said secondary signal paths to said captured weighted signal sum value and said sets of type σ_g, type Q_{gi3}, and type Q_{i3} parameters;

solving said set of linear equations for the values of said type σ_g, type Q_{gi3}, and type Q_{i3} parameters in terms of said unweighted contributions σ_i;

expressing the desired deposited energy type Q_{gT} in terms of said type σ_g, type Q_{gi3}, and type Q_{i3} parameters as

$$Q_{gT} = \sigma_g + \Sigma A_i Q_{gi3}$$

where A_i is the area under an exponential decay of unit amplitude, integrated to infinity; and

substituting from said set of solved linear equations to obtain Q_{gT} in terms of said unweighted contributions σ_i as:

$$Q_{gT} = \Sigma\, w_i\, \sigma_i,$$

where the coefficients w_i of said unweighted contributions σ_i are the desired weighting coefficients.

58. A method for measuring the integrated area Q_{gT} of a pulse-like input signal applied to a device characterized by one or more decay time constants in said device's impulse response function by measuring a step-like output signal, referred to as the primary signal, provided by said device in response to said pulse-like input signal, the method comprising:

creating a set of secondary signals by directing the primary signal into a plurality of signal paths connecting to one or more signal summation points;

performing a filtering or delaying operation in at least one of said signal paths;

applying a set of weighting coefficients to said secondary signals within said signal paths;

summing said secondary signals at said one or more signal summation points to provide a time correlated, weighted filter sum signal; and

performing at least one capturing operation after any filtering or delaying operations to produce a value of said time correlated, weighted filter sum signal, following said capturing and summing operations, that is a measure of said integrated area Q_{gT} of said input signal;

wherein said filtering, delaying and/or capturing operations establish a defined time correlation between said secondary signals with respect to one another prior to reaching said one or more summation points; and

wherein said weighting coefficients applied to the secondary signals are selected, based on the nature of any filters used in said filtering operations, on the defined time correlation established between said secondary signals, and on the values of the one or more decay time constants associated with said device, to compensate said measured area Q_{gT} for the risetime structure of said step-like pulse, for the presence of more than one decay time constant, or for both.

59. Apparatus for measuring the integrated area Q_{gT} of a pulse-like input signal applied to a device characterized by one or more decay time constants in said device's impulse response function by measuring a step-like output signal, referred to as

the primary signal, provided by said device in response to said pulse-like input signal, the apparatus comprising:

a plurality of signal paths that receive the primary signal, the signals traveling along said signal paths being referred to as secondary signals;

at least one filter and/or delay element in at least one of said signal paths;

weighting circuitry that performs a weighting function on said secondary signals within said signal paths;

summing circuitry that sums said secondary signals to provide a time correlated, weighted filter sum signal; and

capturing circuitry that captures said secondary signals after said secondary signals have encountered any filter or delay element in said signal paths to produce a value of said time correlated, weighted filter sum signal, following capturing and summing, that is a measure of said integrated area Q_{gT} of said input signal;

wherein said at least one filter and/or delay element and/or said capturing circuitry establish a defined time correlation between said secondary signals with respect to one another prior to said secondary signals being summed; and

wherein said weighting coefficients applied to the secondary signals are selected, based on the nature of any filters used in said signal paths, on the defined time correlation established between said secondary signals, and on the values of the one or more decay time constants associated with said device, to compensate said measured area Q_{gT} for the risetime structure of said step-like pulse, for the presence of more than one decay time constant, or for both.

60. The apparatus of claim 59 wherein said summing circuitry sums said secondary signals at a single summation point.

61. The apparatus of claim 59 wherein said summing circuitry sums said secondary signals at a plurality of summation points.

62. The apparatus of claim 59 wherein at least one secondary signal encounters said weighting circuitry prior to encountering a filter or delay element in that secondary signal's respective signal path.

63. The apparatus of claim 59 wherein at least one secondary signal encounters a filter prior to encountering a delay element or said weighting circuitry in that secondary signal's respective signal path.

64. The apparatus of claim 59 wherein at least one secondary signal encounters a delay element prior to encountering a filter or said weighting circuitry in that secondary signal's respective signal path.

65. A method for determining the integrated area Q_{gT} of a pulse-like input signal by measuring a step-like output signal provided by a nominally single-pole (N-1P) device in response to said pulse-like input signal, the method comprising:

applying a filter set having one or more filters to said N-1P device output;

detecting the presence of a step-like feature in said output signal;

in response to detecting said feature, capturing a set of correlated multiple output sample values (the area cMOS) from one or more filters in said filter set; and

forming a weighted sum of the sample values in said area cMOS to determine said integrated area Q_{gT} (the determined area) of said input signal;

wherein the weights in said sum (the area weights) are selected to compensate said determined area for errors arising either from the time structure of said pulse-like input, or from deviations in the N-1P device's response from an ideal single-pole response, or from both.